United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

In Reply Refer to:
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Wendy R. Dixon
EIS Project Manager
Yucca Mountain Site Characterization Office
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
P.O. Box 30307, Mail Stop 010
North Las Vegas, Nevada 89036-0307

Dear Ms. Dixon:

The United States Department of the Interior (Department) has reviewed the draft environmental impact statement (DEIS) for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, and offers the following comments.

BACKGROUND INFORMATION

The Nuclear Waste Policy Act (NWPA) was enacted by Congress in 1982 in recognition of the need to provide for the permanent disposal of spent nuclear fuel and high-level radioactive waste in the United States. Currently, approximately 70,000 metric tons of heavy metal (MTHM) of spent nuclear fuel and high-level radioactive waste is housed at some 77 sites across the United States. In 1986, the Department of Energy (DOE) narrowed the number of potentially acceptable sites for a geologic repository to three (3) sites in three (3) States. However, Congress in 1987 amended the NWPA and directed the Secretary of Energy to characterize only the Yucca Mountain as a potential location for a geologic repository, setting forth a process for the Federal Government to decide whether to designate Yucca Mountain as the site for a repository. Yucca Mountain is located in Nye County, Nevada, approximately 100 miles northwest of Las Vegas, Nevada, on the western boundary of the Nevada Test Site (NTS).

POTENTIAL ADVERSE IMPACTS TO BIOLOGICAL RESOURCES

1... The Department's Fish and Wildlife Service (Service) is responsible for protection of trust resources which include species listed as threatened or endangered under the Endangered Species Act of 1973 (ESA), as amended, birds protected under the Migratory Bird Treaty Act, and other biological resources managed under the National Wildlife Refuge (NWR) System. The Service is concerned with possible adverse effects to these and other resources that could

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1 cont. result from the operation of the Yucca Mountain facility. Trust resources on or in the vicinity of the proposed waste storage facility include the following:

- Yucca Mountain is at the northern edge of the range for the desert tortoise (*Gopherus agassizii*) which is listed as threatened under the ESA. On July 23, 1997, the Service issued a biological opinion to DOE for programmatic activities associated with site characterization studies at Yucca Mountain (File No. 1-5-96-F-307R).

- Rainfall runoff accumulating in low lying areas at the NTS such as Frenchman Flat, attract migratory birds to the area.

- The Desert National Wildlife Range, located approximately 30 miles to the east of the proposed repository, provides habitat for numerous wildlife species that are unique to the Mojave Desert ecosystem.

- The Ash Meadows NWR is located approximately 25 miles south of Yucca Mountain and provides habitat for 12 species listed under the ESA, including the Devils Hole pupfish (*Cyprinodon diabolis)* and Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes).* Ash Meadows also provides aquatic and riparian habitat essential for other sensitive species of plants and invertebrates and for migratory and resident bird species. These and other wildlife species are dependent upon several free-flowing springs within the boundary of the refuge.

2... The NWPA requires DOE to provide reasonable assurance that the environment will be protected from the hazards posed by the Yucca Mountain repository. In order to meet this requirement, DOE has conducted numerous detailed analyses of Yucca Mountain's geology and hydrology for the past 15 years. Through these and other activities associated with site characterization, DOE has amassed a large body of evidence to support the likely determination that Yucca Mountain is the most suitable site to store the nation's high-level nuclear waste. Despite the fact that the most advanced technology is being utilized to design a foolproof waste barrier system for the repository and given the fact that the waste would remain radioactive for many thousands of years, we continue to be concerned that a facility of this nature inherently poses some degree of risk to wildlife resources. Our primary concerns are as follows:

Groundwater flows in aquifers below Yucca Mountain are generally to the south. Therefore, radionuclides and toxic chemicals, if introduced to the groundwater either by a short-term catastrophic event (e.g. earthquake, flood) or through long-term (i.e. >1,000 years) degradation of the waste storage containers, could eventually migrate to environmentally sensitive areas such as Ash Meadows NWR. A recent study found that the plutonium compound PuO2, once thought to be the most stable form of plutonium waste, can be oxidized by water making it more soluble and increasing the risk of groundwater contamination from storage facilities (Haschke et al. 2000).

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2 cont. We find these and other uncertainties associated with containment of high level radioactive waste to be cause for concer..

3 Transportation of high level radioactive waste to Yucca Mountain by truck or rail from nuclear facilities nationwide also has the potential to impact wildlife resources should a breach in containment occur. There is an inherent risk associated with transportation of any hazardous material. Although DOE has conducted detailed analysis of worst-case scenarios, even the best waste management strategies cannot predict every possibility. We understand that the radioactive waste would be transported in a virtually leak-proof stainless steel cask in the form of dry pellets which would make release of any waste material extremely remote. Nevertheless, there remains a potential environmental risk, albeit minuscule, at any given point along the proposed rail or highway transportation corridor.

4 Cumulative environmental effects from the future operation of the Yucca Mountain repository and past activities at the NTS are also of concern. Possible impacts to groundwater and spring discharges resulting from activities at NTS, approximately 25 miles north of Ash Meadows NWR, are being evaluated by DOE, the Service and the U.S. Geological Survey (USGS). Activities at the NTS which may have resulted in contamination of the region include both atmospheric and subterranean tests of nuclear devices and other tests involving radioactive materials, controlled atmospheric releases of numerous gaseous materials, and disposal and destruction of various types of solid and liquid wastes. The extent to which these activities have placed wildlife resources at risk is still under investigation. DOE's Environmental Management Program is focused on identifying the nature and extent of contamination from the nuclear weapons programs at DOE facilities. This process is underway at the NTS with ongoing environmental restoration and waste management activities.

ACCIDENTS

5 We agree with the DOE that a major accident involving a shipment of this material is of low probability with a level of general uncertainty, and therefore, is not quantified to be zero. Moving70,000 metric tons of high- level nuclear waste, including 50 metric tons of weapons grade materials, from sites that are almost entirely east of the Mississippi River, over a 100 year period, almost ensures that an accident will occur, sometime, somewhere. Testing has shown that conditions exist under which shipping casks can be penetrated or ruptured (page 6-33 of the EIS). It is not clear in the draft whether a head-on truck or train collisions and train derailments will produce such conditions but it is important that the final EIS address DOE's plans to contain or control such events and their impacts.

SABOTAGE

6 That there are devices already in existence that can penetrate the truck shipping casks (page 6-33 of the EIS) if used by saboteurs, must not be taken lightly. That the trains and trucks will be guarded solves part of the problem, but not entirely. It is presumed that the guards will be armed, but would that protect against an intentional derailment? If the act of sabotage is successful, how would DOE address response and cleanup or control?

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HIJACKING

7 We could find no mention, in the EIS, of the possibility of one of the trucks being hijacked. A hijacked truck could be driven anywhere and used as a threat. A hijacked trucks would be most vulnerable when they are stopped so that the guards and drivers can eat or sleep. How does DOE plan to address this situation?

RADIATION

8 If we are interpreting Table 4-34 (page 4-59) correctly, over a 70 year life span a person living within 12 miles of the repository would receive a life time radiation dose of between 38 to 100 millirems from the repository depending on the thermal load scenario used. Is this correct? If so, it is significantly lower than the NRC's standard of 100 millirems per year at abandoned mines after reclamation. We believe that it is unusual that a person residing near this repository would receive less radiation than would one who lived near many other areas containing less radiation, such as abandoned mine sites. If our interpretation is incorrect, and the correct dose rate is between 38 and 100 millirems per year, then the low thermal load matches the NRC standard. Perhaps this figure needs to be reevaluated in the final EIS to clear up this ambiguity.

CONFLICTS WITH EXISTING LAND USES

9 The need for rights of way across public lands to access the Yucca Mountain Facility could create conflicts with existing land uses in the area through traffic, construction, accidents and incidental spillage of nuclear materials containers. How will these be addressed?

SPECIFIC COMMENTS:

Draft Environmental Impact Statement, Summary.

10 **Page S-36, 5.4.1.3 Geology, first paragraph.**

Most of the faulting that affected Yucca Mountain occurred during the 11.4 to 14 Ma interval of volcanic activity and not subsequent to the activity, as stated in the text.

11 **Page S-36, 5.4.1.3 Geology, second paragraph.**

The correct name of the repository host rock is the Topopah Spring Tuff, not "Topopah Springs Formation" or "Topopah Springs formation."

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12 **Page S-37, 5.4.1.3 Geology, first paragraph.**

Point (3) states that the Topopah Spring Tuff was chosen because of ". . . its location away from major faults that could adversely affect the stability of underground openings. . ." This statement implies that the Topopah Spring Tuff is not intersected by major faults, which it most assuredly is. Faults cut through all of the Tertiary volcanic units in the proposed repository area, including the Topopah Spring Tuff. Solitario Canyon fault and several other known faults cut through the Topopah Spring Tuff, some immediately adjacent to the underground facilities.

The relationship between faulting and the selection criteria of the Topopah Spring Tuff as the repository host rock in the Summary and the Draft EIS itself (page 3-24) is unclear and needs more detailed and accurate explanation. The selection of Topopah Spring Tuff cannot be predicated on its lack of proximity to seismically active faults. If so, the site would not be viable. Clarification is needed.

13 **Page S-37, second paragraph.**

The statement, "The Solitario Canyon fault forms the major bounding fault on the west side of Yucca Mountain, and volcanic units in the mountain tilt eastward as a result of displacement along this and lesser faults through the mountain . . .," needs clarification. There are faults on the east side of Yucca Mountain. The faults that bound the eastern side of the proposed repository area, the Bow Ridge and Paintbrush Canyon faults, to name just two (see table 3-8, Characteristics of major faults at Yucca Mountain, v. 1 - Impact Analysis, Draft EIS), need to be mentioned here. Additionally, because these latter two north-trending faults dip to the west beneath the repository area and the adjacent material handling facilities that would be built at the north and south portals, understanding the seismic hazard potential of these faults is extremely important.

In addition, easterly tilts are not the result of movement on the Solitario Canyon fault and "lesser faults through the mountain." These tilts are the result of movement on a whole series of block-bounding faults, of which the Solitario Canyon fault is one.

Draft Environmental Impact Statement.

14 **Page 3-14, Section 3.1.3.1 Physiography (Characteristic Land forms).**

This section label and content are confusing. The unnumbered subsections on Site Stratigraphy and Lithology, Selection of Repository Host Rock, and Potential for Volcanism at the Yucca Mountain site should be numbered subsections under the main section 3.1.3, Geology, and not the subsection of Physiography, to which they have little relation.

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15 **Page 3-16, Site Stratigraphy and Lithology.**

The sedimentary history of the region including the Tertiary sedimentary rocks (for example Pavits Springs Formation) need to be discussed in this section and included in Table 3-6 (page 3-19).

16 "Paleozoic and Precambrian" need to be substituted for "pre-Cenozoic" in order to correspond with the wording in the referenced Table 3-6, page 3-19.

17 **Page 3-19, first paragraph.**

The "pre-Cenozoic" (see above) rocks are also exposed at Calico Hills and Striped Hills, which are as close or closer to Yucca Mountain than are the pre-Cenozoic rocks at Bare Mountain, and therefore should be included in the discussion.

For clarity, the borehole (first paragraph) should be described as 2 kilometers east of the crest of Yucca Mountain, because Yucca Mountain is physiographically defined as all the numerous ridges that surround the borehole.

18 **Page 3-21, last paragraph.**

The statement, "Volcanic rocks younger than the Tertiary units. . .," is incorrect. Most of the volcanic rocks are Tertiary in age, including the Skull/Little Skull lava flows, the lava flow at the south edge of Crater Flat, the 10 Ma basaltic dike, and the 3.7-Ma cones and flows in Crater Flat.

19... **Page 3-22, Figure 3-7, General bedrock geology of the proposed repository Central Block area.**

This figure is inaccurate and does not correctly correspond to Figures 3-8, 3-10, or the original geologic map (Day and others, 1998). The following changes and/or additions need to be made:

a. The configuration of the Drill Hole Wash fault needs to be mapped as shown in Figure 3-10.

b. The Ghost Dance fault needs to continue to the southwest and not abruptly terminate as shown is this Figure (see Figure 3-10).

c. The zone of intense faulting between the Bow Ridge and Ghost Dance faults is missing. This zone connects with the Dune Wash fault. These faults are shown in the cross-section (Figure 3-8).

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19 cont.

d. The small intra block faults need to be included in the Figure because the contacts are drawn incorrectly without them. Figure 3-8 cannot be reconciled with Figure 3-7 without these mapped faults.

e. For clarity, the cross-section line in Figures 3-7 and 3-8 should be named A-A', not B-B', because there is only one cross section on these maps.

f. Because no lower block is shown, the "upper block" text needs to be deleted from the "Proposed drift boundary" in the Legend.

20 **Page 3-23, Figure 3-8, Simplified geologic cross-section of Yucca Mountain, West to east.**

The mismatch of contacts between units, which appears as wiggles, is incorrect. The Figure needs to show these contacts correctly.

21 **Page 3-24, first paragraph, and Page 3-33, Flood Potential.**

Boulders as large as 2 meters in diameter, as well as sand, silt, and clay, are part of the alluvial deposits on these fans and stream beds. This boulder-size material has the potential for significant destructive force during the flash floods.

22 **Page 3-25, Section 3.1.3.2 Geologic Structure.**

Discussion of the occurrence of joints and fractures in the volcanic rock at Yucca Mountain is needed in this section, including mention of the geographic and stratigraphic distribution of fractures, and whether they are fault- and/or stratigraphically-controlled.

23 **Page 3-25, Section 3.1.3.2 Geologic Structure, second paragraph.**

"Major crustal compression" and "crustal extension" need to have an associated direction, such as "Major east-west crustal compression" and "east-west crustal extension."

Crustal compression is stated to have occurred between 350 and 50 Ma, but there is no evidence for east-west compression younger than about 100 Ma in this region.

24 Day and others 1996 should be changed to 1998, both here and in the References (page 12-8).

25... **Page 3-25, Section 3.1.3.2 Geologic Structure, fifth paragraph.**

It is stated here that the ". . . total estimated displacement on the most active block-bounding faults . . . during the past 1.6 million years is less than 50 meters. . . (Simonds and others, 1995)." This statement is from the Conclusion section of Simonds and others (1995) and is misleading

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25 cont. when taken out of context. All measurements of Quaternary (1.6 Ma to present) displacement on these faults range from 0 to 6 m with most displacement in the 1-2.5 m range, as reported in Table 2 of Simonds and others (1995). Reference Table 3-8 in this paragraph to help clarify this point.

26 **Page 3-25, Section 3.1.3.2 Geologic Structure, sixth paragraph.**

The statement, "The Solitario Canyon fault along the west side of Yucca Mountain is **the** major block-bounding fault . . .," is incorrect. The Solitario Canyon fault is one of numerous block-bounding faults that are shown on Figure 3-10. These include the Northern Windy Wash, Fatigue Wash, Solitario, Iron Ridge, Dune Wash Bow Ridge, Midway Valley, Paintbrush Canyon faults, just to name those within 4 km radius of the proposed perimeter of the repository.

27 **Page 3-25, Section 3.1.3.2 Geologic Structure, last paragraph.**

This short treatment of intra block faults (the subsidiary faults between the block bounding faults) places undue emphasis on NW-trending faults by discussing them first. Within the central block, where the repository would be sited, the intra block faults with the longest map traces and the largest amounts of displacement are the Ghost Dance Fault (splitting the center of the block) and the block-margin faults ("Imbricate Zone" of Scott, 1990) that are just west of the Bow Ridge Fault. Day and others (1998, USGS Map I-2601) and Scott and Bonk (1984) also document this. The NW- trending faults, such as the Sundance Fault, though characterized correctly, are relatively minor in comparison (Potter and others, USGS OFR 98-266, in press). It would be more appropriate to mention the much larger Ghost Dance fault first.

28 **Page 3-26, Figure 3-9, Types of geologic faults.**

For clarity, definitions of normal and reverse faults need to uniquely specify the correct sense of motion. For a normal fault reword the description, "dip-slip fault where one block has moved downdip relative to the other," to "dip-slip fault where the upper block has moved downdip relative to the lower block." For reverse fault, reword "dip-slip fault where one block has moved updip relative to the other" to "dip-slip fault where the upper block has moved updip relative to the lower block."

A diagram is needed for low-angle normal faults, such as in Calico Hills east, and Bare Mountain west, of Yucca Mountain.

29 **Page 3-27, Figure 3-10, Mapped faults at Yucca Mountain and in the Yucca Mountain vicinity.**

In the legend, the strike-slip fault symbol should have arrows showing relative sense of lateral motion (as on map), as well as an explanation of the strike-slip symbol. As it is, the legend only shows the dip-slip component on these faults.

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30 **Page 3-28, Table 3-8, Characteristics of major faults at Yucca Mountain.**

Define the late Quaternary in years for clarity.

31 **Page 3-29, Section 3.1.3.3 Modern Seismic Activity.**

The seismicity map with faults needs to be shown here as a numbered Figure.

32 **Page 3-30, fifth paragraph.**

The correct statement is that there is no observable strain measured *within the error of the data.*

33 **Page 3-30, Section 3.1.3.4 Mineral and Energy Resources.**

There is no discussion of energy resources in this section. The Yucca Mountain site is about 200 km SW of producing oil fields in Railroad Valley (one of two valleys in the state that have produced commercial oil). Published literature on the presence or absence of oil resources in the Yucca Mountain/NTS area include Chamberlain (1991 AAPG abstract), who suggested that Yucca Mountain is situated over a billion-barrel oil field, and Trexler and others (1996, AAPG Bulletin v. 80, no. 1), who disputed this, as did Grow and others (Hi-Level Waste Proceedings, 1994). Although it appears that there is a low potential for mineral and energy resources in the context of today's recovery technology, a discussion of the potential resources should be included here.

34 **Page 3-36, Section 3.1.4.2.1 Regional Groundwater.**

There is insufficient data to fully characterize the site-scale hydrology of the area. Because of the complexity of the geology and inconsistencies between the Large Hydraulic Gradient and thermal data, additional boreholes, appropriately configured, that penetrate to the Paleozoic carbonates beneath the Tertiary tuffs should be considered.

There is a lack of data on the hydrologic interaction between the Tertiary tufts and the underlying Paleozoic carbonate aquifers.

35 **Page 3-39 and Page 3-51, Section 3.1.4.2 Groundwater.**

The **range** of infiltration rates, hydraulic conductivities, etc. should be used rather than the average, especially in the case where the range is large. For example, apparent hydraulic conductivities range over 3 orders of magnitude (page 3-51). Also, the average infiltration rate of 6.5 mm/yr on page 3-39 is misleading because fracture systems allow much more rapid flow locally. The difficulty of Yucca Mountain hydrology is in the inability to predict which fractures or faults will act as highly transmissive zones. Care must be taken to show ranges of behavior so that best and worst case scenarios can both be evaluated.

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36 **Page 3-79, Section 3.1.8 Occupational and Public Health and Safety.**

The radiological hazards and their consequences were discussed in a concise way such that the average citizen can draw conclusions about the risks of the proposed and alternative actions. The background information that was provided to develop an understanding of ionizing radiation and the hazards/risks was especially helpful.

37 In summary, as DOE continues to further characterize the suitability of the proposed Yucca Mountain site in sufficiently isolating high-level radioactive waste and spent nuclear fuel, we look forward to continued coordination on protection of the Department's trust wildlife and other resources. The Service's Southern Nevada Field Office is interested and available to provide technical support in development and implementation of monitoring programs for Yucca Mountain operations. The Service's technical support can be integrated with ongoing groundwater monitoring programs by several other agencies in the vicinity of Yucca Mountain. DOE and USGS have collaborated since 1989 on the Environmental Monitoring Program in order to better understand the hydrology of this area. Monitoring is essential in our view and will help to ensure that any changes in the environment are detected and investigated appropriately. We look forward to working with the DOE on this important national initiative.

The Department appreciates the opportunity to review this DEIS. We hope our comments will be useful in evaluating the Yucca Mountain site for a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste. References are included on the following page.

Should you have any questions or wish to discuss our comments further, please do not hesitate to call Dr. Vijai N. Rai of this Office at (202)208-6661.

Sincerely,

Willie R. Taylor
Director
Office of Environmental Policy
and Compliance

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REFERENCES:

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RESPONSES TO U.S. DEPARTMENT OF THE INTERIOR COMMENTS ON THE DRAFT EIS (Comment Document 1969)

1. On December 17, 1998, DOE requested a species list from the U.S. Fish and Wildlife Service and initiated consultation to evaluate whether the Proposed Action could affect the threatened desert tortoise or protected species at Ash Meadows, Devils Hole, or along transportation corridors. In a Biological Assessment submitted to the U.S. Fish and Wildlife Service on April 24, 2000, DOE concluded that the Proposed Action would not affect the listed species in the Ash Meadows or Devils Hole areas because these areas are in a different regional groundwater sub-basin from Yucca Mountain. The Fish and Wildlife Service concurred with this conclusion during consultation on the effects of repository construction, operation and monitoring, and closure on threatened and endangered species (see the Fish and Wildlife Service Final Biological Opinion in Appendix O of the EIS). Furthermore, there are no playas in the vicinity of Yucca Mountain where surface water could accumulate and attract migratory birds. The playa at Frenchman Flat is located approximately 35 kilometers (22 miles) east of Yucca Mountain and would be unaffected by the Proposed Action.

   DOE did determine that the Proposed Action could affect the desert tortoise and consequently has proposed mitigation measures to minimize effects. If the Secretary of Energy recommends approval of the Yucca Mountain site to the President, and Yucca Mountain is ultimately authorized for the disposal of spent nuclear fuel and high-level radioactive waste, DOE would implement all reasonable and prudent mitigation measures and comply with the terms and conditions of the Final Biological Opinion from the U.S. Fish and Wildlife Service. See Appendix O of the EIS for the Opinion.

   The Desert National Wildlife Range, approximately 48 kilometers (30 miles) east of the repository, would be unaffected by the Proposed Action unless the Valley Modified Corridor, which could be on, or adjacent to, the southern boundary of the Range, was selected. With regard to the transportation implementing alternatives in the State of Nevada, DOE believes this EIS is sufficient for the determination of the relative merits and a selection decision among the various corridors and shipment modes discussed in the EIS, but acknowledges additional environmental review would be required to assess the potential impacts of specific route alignment within a corridor. DOE would continue discussions with the U.S. Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act, as amended, on any corridor or alignment within a corridor determined to require further environmental review and would implement the terms and conditions of any subsequent Biological Opinions.

2. DOE believes that the comments expressed by the U.S. Fish and Wildlife Service concerning risks to wildlife resources are addressed in the EIS. Section 4.1.8 of the EIS discusses the potential for catastrophic events (including earthquakes) occurring at the Yucca Mountain Repository during construction, operation and monitoring, and closure of the repository, and the consequences of these events. As described in Section 4.1.3, flooding would be unlikely to release contaminants because the design of critical surface facilities would withstand the most severe reasonably possible floods. Chapter 5 discusses impacts from the long-term performance of the repository. The evaluations included impacts from volcanic (Section 5.7.2) and seismic disturbances, as well as impacts from the slow degradation of waste packages over thousands of years. This slow degradation has the highest potential to spread contaminants as they are leached into the groundwater beneath Yucca Mountain.

   Section 3.1.4.2.1 of the EIS shows that the flow path of groundwater from Yucca Mountain extends to Jackass Flats and the Amargosa Desert, and continues southward to the primary point of discharge at Franklin Lake Playa in Alkali Flat. The EIS recognizes that some groundwater reaching this far might bypass Franklin Lake Playa and continue into Death Valley. The EIS also recognizes that a fraction of the groundwater that reaches the Amargosa Desert might flow through the southeastern end of the Funeral Mountains to springs in the Furnace Creek Wash in Death Valley National Park. The springs in Ash Meadows (including Devils Hole) are not along the groundwater flow path from Yucca Mountain. As described in Section 3.1.4.2.1, groundwater beneath Yucca Mountain flows to the Amargosa Desert but does not discharge in Ash Meadows. From Ash Meadows to the low axis (Carson Slough) of the Amargosa Desert, the groundwater table declines

about 64 meters (210 feet), indicating that the groundwater flows from Ash Meadows toward the Amargosa Desert, not the other way around.

Chapter 5 of the EIS does not specifically address the risks to people and natural resources in Death Valley National Park from the use and consumption of groundwater. However, it clearly indicates that risks would decrease with increased distance from the repository. Accordingly, impacts to the Park, because it is far from Yucca Mountain, would be negligible.

In Section 5.3 of the EIS, DOE concluded that the predicted long-term levels of radionuclide concentrations in groundwater and the resulting dose levels at the predicted discharge area in Amargosa Valley would be low. As a consequence, DOE does not expect that the dose rates to plants and animals would cause measurable detrimental effects in populations of any species because the rates would be less than 100 millirad per day. The International Atomic Energy Agency concluded that chronic dose rates of much less than 100 millirad per day are unlikely to cause measurable detrimental effects in populations of even the more radiosensitive species in terrestrial ecosystems (DIRS 103277-IAEA 1992). The DOE interim technical standard, *A Graded Approach for Evaluating Dose to Aquatic and Terrestrial Biota*, which the Department made available for interim use on July 20, 2000, contains more information about potential effects of radiation on biota.

The comment also refers to a recent laboratory finding that a species of plutonium oxide has a higher solubility than the species most often considered to be the normal oxidized form of the metal (plutonium dioxide) (DIRS 150367-Haschke, Allen, and Morales 2000). Scientists working on the Yucca Mountain Project are aware of this finding. DOE believes that the finding is within the range of conservatisms built into the plutonium solubility model used to model the long-term performance of the repository.

3. DOE agrees that a release of hazardous materials during accidents involving spent nuclear fuel or high-level radioactive waste would be very unlikely. With regard to the potential impacts to wildlife resources, a transportation accident could result in the dispersal or death of individual members of a species within a localized area but would be unlikely to have long-term detrimental effects upon a population as a whole.

4. This comment accurately summarizes some of the issues involving the potential cumulative impacts associated with the Proposed Action and some of the ongoing evaluations being conducted by the Department and other agencies, including the U.S. Fish and Wildlife Service. In preparing Chapter 8 of the EIS, the Department reviewed many past, present, and reasonably foreseeable future actions to determine where there was potential for cumulative impacts. Chapter 8 of the EIS describes both the short-term and long-term impacts of the proposed repository, along with transportation and manufacturing cumulative impacts.

5. The shipping casks used to transport these spent nuclear fuel and high-level radioactive waste are massive and tough with design features that comply with strict regulatory requirements that ensure the casks perform their safety functions even when damaged. Numerous tests and extensive analyses have demonstrated that casks would provide containment and shielding even under the most severe kinds of accidents. In addition, since the publication of the Draft EIS, the Nuclear Regulatory Commission published *Reexamination of Spent Fuel Shipment Risk Estimates* (DIRS 152476-Sprung et al. 2000). Based on the revised analyses, DOE has concluded in the EIS that casks would continue to contain spent nuclear fuel fully in more than 99.99 percent of all accidents (of the thousands of shipments over the last 30 years, none has resulted in an injury due to release of radioactive materials). This means that of the approximately 53,000 truck shipments, there would be an estimated 66 accidents, each having less than a 0.01-percent chance that radioactive materials would be released. The chance of a rail accident that would cause a release from a cask would be even less. The corresponding chance that such an accident would occur in any particular locale would be extremely low. Section J.1.4.2.1 of the EIS presents consequences for accidents that could release radioactive materials.

With regard to the containment or control of accident events, DOE would rely on a number of actions including the training of public safety officials and the implementation of safeguards and security plans. Section 180(c) of the NWPA requires DOE to provide technical assistance and funds to states for training public safety officials and appropriate units of local government and tribes through whose jurisdictions DOE

shipments would pass. DOE anticipates financial and technical assistance to eligible jurisdictions to begin at least 4 years before the commencement of shipments to the repository.

Concerning safeguards and security plans, DOE would comply with all requirements of 10 CFR Part 73, including preshipment planning, communications, armed escorts and tamper-indicating devices on shipping casks. Regarding shipment routes, pursuant to U.S. Department of Transportation regulations, 49 CFR 397.101 and DIRS 154766-NRC (1980), added protection would be afforded by the selection of routes which exhibit certain criteria including the likelihood of swift law enforcement response, avoidance of tactically disadvantageous locations such as long tunnels or bridges spanning heavily populated areas, and flexibility to adjust schedules to accommodate unexpected situations.

6. Transportation shipments would be protected from sabotage. The Nuclear Regulatory Commission has developed a set of rules specifically aimed at protecting the public from harm that could result from sabotage of spent nuclear fuel casks. Known as physical protection or safeguards regulations (10 CFR 73.37), these security rules are distinguished from other regulations that deal with issues of safety affecting the environment and public health. The objectives of the safeguards regulations are to minimize the possibility of sabotage and facilitate recovery of spent nuclear fuel shipments that could come under control of unauthorized persons.

   Cask safety features that provide containment, shielding, and thermal protection also provide protection against sabotage. The casks would be massive. The spent nuclear fuel in a cask would typically be only about 10 percent of the gross weight; the remaining 90 percent would be shielding and structure.

   Although it is not possible to predict the types of potential sabotage events with certainty, DOE has examined various accident scenarios, which can provide a sense of the consequences that could occur in such events. In addition, DOE has specifically analyzed the potential consequences of sabotage against a truck or rail cask. The results of this analysis indicate that the maximally exposed individual would increase the risk of incurring a fatal cancer from approximately 23 percent (the current risk of incurring a fatal cancer from all other causes) to about 29 percent. The same event could cause 48 latent cancer fatalities in an assumed population of a large urban area.

   Because of the attacks on September 11, 2001, the Department and other agencies are reexamining the protections built into their physical security and safeguards systems for transportation shipments. As dictated by results of this reexamination, DOE would modify its methods and systems as appropriate.

   In response to public comments, DOE has included a discussion on the range of potential costs of cleanup following a severe transportation accident in Appendix J of the EIS. This discussion reviews calculations of land area contaminated and costs for cleanup presented in past studies, including a report used in the 1986 Environmental Assessments (DIRS 154814-Sundquist et al. 1985), and information submitted by the State of Nevada in its comments on the Draft EIS. The information submitted by the State included estimates of cleanup costs as high as $270 billion. Cost data used in the studies reviewed in Section J.1.4.2.5 included data compiled from case studies involving actual cleanup of radioactive materials contamination. Section J.1.4.2.5 discusses environmental restoration after a release of radioactive material.

7. Transportation shipments would be protected from sabotage. The Nuclear Regulatory Commission has developed a set of rules specifically aimed at protecting the public from harm that could result from sabotage of spent nuclear fuel casks. Known as physical protection or safeguards regulations (10 CFR 73.37), these security rules are distinguished from other regulations that deal with issues of safety affecting the environment and public health. The objectives of the safeguards regulations are to minimize the possibility of sabotage and facilitate recovery of spent nuclear fuel shipments that could come under control of unauthorized persons.

8. The interpretation is correct. In the Draft EIS, the maximally exposed individual would receive an estimated dose of 38 to 100 millirem over 70 years. Table 4-35 (Footnote c) and Section 4.1.7.5.3 of the Draft EIS explain this dose. Section 4.1.2 of the EIS discusses the highest potential annual dose would be less than 2 millirem per year.

Exposure scenarios at reclaimed uranium mines or mills are much different from the potential exposure near the proposed repository at the Yucca Mountain site. The key differences at Yucca Mountain would be the lack of high uranium and uranium decay product source material, lack of tailings with enhanced concentrations of uranium decay chain radionuclides, and the location of the potential public dose receptor at the boundary of the controlled area (15 millirem per 40 CFR Part 197). Further, potential public exposures at Yucca Mountain would be held to a much more rigorous standard than 100 millirem per year. The discussions in Sections 4.1.2 and 4.1.7, along with the supporting information in Section G.2, explain potential public radiation doses.

9. Sections 6.3.1, 6.3.2, and 6.3.3 of the EIS address the potential impacts of Nevada legal-weight truck, heavy-haul truck, and branch rail line implementing alternatives, respectively, including land-use impacts. These sections recognize and describe the impacts related to construction and operation of branch rail lines and developing or upgrading highways, including traffic impacts. Section 6.2.4.2 addresses impacts from accidents, including spills.

   DOE acknowledges that some land-use conflicts could be inevitable during the construction and operation of a transportation corridor for the Yucca Mountain Repository. The implementing alternatives for transportation described in the EIS were based in part on attempts to avoid or minimize potential land-use conflicts.

   DOE has identified mostly rail as its preferred mode of transportation, both nationally and in Nevada. At this time, however, the Department has not identified a preference among the five candidate rail corridors in Nevada. Should the branch rail line implementing alternative be selected and a preferred rail corridor identified, additional engineering and environmental studies would be conducted as a basis for detailed design and for appropriate National Environmental Policy Act reviews. During this process, DOE would initiate consultations with responsible local, State, Federal, and tribal agencies, landowners, and other stakeholders to identify, acquire, and evaluate additional information and develop mitigative actions necessary to minimize potential impacts, including land use.

10. DOE agrees that most of the faulting occurred during this period and Section S.4.1.3 of the EIS Summary has been changed to, "Yucca Mountain is a product of volcanic and seismic activity that occurred 14 million to 11.5 million years ago."

11. DOE has corrected the name of the repository host rock to "Topopah Spring Tuff."

12. DOE agrees that it cannot predicate its selection of the Topopah Spring Tuff for the repository on the lack of proximity to seismically active faults. The Department has changed the statement in the Summary and Section 3.1.3 of the EIS to indicate that it chose the repository emplacement area because of its location away from major faults that could adversely affect the stability of underground openings.

13. The comment is correct that the Solitario Canyon fault is not the only block-bounding fault identified in the EIS. However, DOE did not modify the text of the Summary in order to keep it understandable to a wide range of readers. DOE has, however, clarified the text in Section 3.1.3.2 of the EIS, which also refers readers to numerous reference materials on the subject.

14. The purpose of Section 3.1.3.1 is to provide a broad overview of regional and site geology. The purpose of the subsections that are part of Section 3.1.3.1 is to address specific issues of particular concern or interest to the public (such as faulting and seismic activity) or that are a definite change of topic (for example, mineral and energy resources). DOE agrees that it could put the topics identified in the comment in separately numbered sections, but made an editorial decision not to do so.

15. Although the EIS is concerned with the sedimentary history of the region and sedimentary rock units at Yucca Mountain, the main focus is on those units important for the study of groundwater infiltration, flow, and transport. Table 3-6 is highly generalized and identifies only the Topopah Spring Tuff, the repository host rock, by name. The commenter is referred to other parts of Section 3.1.3 of the EIS that describe the

history and stratigraphy of the Yucca Mountain area, and to Table 3-7, which describes the Tertiary rock units at Yucca Mountain in more detail than Table 3-6.

16. DOE has revised the text of Section 3.1.3.1 of the EIS such that the parenthetical explanation "(that is, Paleozoic and Precambrian)" follows the reference to Pre-Cenozoic.

17. This comment is correct. DOE has revised Section 3.1.3.1 of the EIS to include the exposures at Calico Hills and Striped Hills.

18. DOE has revised Section 3.1.3.1 of the EIS to state that volcanic rocks younger than Tertiary age pertain only to the four northeast-trending cinder cones in the center of Crater Flat, dated at about 1 million years old, and the Lathrop Wells basaltic cinder cone, dated at 70,000 to 90,000 years old.

19. DOE has updated the general bedrock geology figure in Section 3.1.3.1 in the EIS as described in the comment to show additional faults in the repository block area. The figure is now consistent with the simplified geologic cross-section figure that follows it.

    This comment suggested that the cross-section line in these figures should be named A-A', not B-B'. DOE has made this modification.

    DOE provided the upper block label in the figure to help the reader identify the area shown because the EIS discusses other blocks.

20. The maps in Chapter 3 of the EIS depicting fault information are simplified and show only selected faults. However, DOE has added more faults to the general bedrock geology in Section 3.1.3.1 to make it more consistent with the cross-section figure that follows.

21. Section 3.1.3 of the EIS has been changed to indicate that the alluvial deposits on fans and in stream beds includes boulders, cobbles, pebbles, sand, silt and clay; Section 3.1.4.1.2 has been modified to indicate that mud flows may include boulder-size material.

22. DOE has modified the discussion in Section 3.1.3.2 of the EIS. The faults described are well-defined structures; joints, along which there is no appreciable movement, also occur in the rock units mapped at the site. Within the Paintbrush Group (Tiva Canyon, Yucca Mountain, Pah Canyon, and Topopah Spring tuffs), joints have been subdivided into three groups based on how they developed and their approximate time of origin: early cooling joints, later tectonic joints, and joints due to erosional unloading (DIRS 151945-CRWMS M&O 2000). Each group of joints exhibits specific characteristics with respect to joint length, orientation, and connectivity. The cooling and tectonic joints have similar orientations (generally trending north-south), whereas cooling joints include irregularly spaced horizontal joints as well. Joints that developed from erosional unloading are variably oriented but trend predominantly east to west, perpendicular to the cooling and tectonic joints. Tectonic joints occur throughout the Paintbrush Group; cooling joints occur in each of the welded units. In general, the Tiva Canyon tuff and the Topopah Spring tuff have the highest joint frequencies and joint connectivities. The nonwelded Yucca Mountain tuff and the Pah Canyon tuff have the fewest joints. Geologic, geoengineering, and hydrologic aspects of fractures are discussed in detail in the *Yucca Mountain Site Description* (DIRS 151945-CRWMS M&O 2000). DOE has added to Section 3.1.3.2 of the EIS more information about joints and fractures in the volcanic rock at Yucca Mountain.

23. The text in Section 3.1.3.2 has been modified to indicate that major east-west crustal compression occurred periodically in the Great Basin between about 350 million years ago to about 65 million years ago. This compression moved large sheets of older rock great distances upward and eastward over younger rocks to produce mountains. References to support this discussion include Armstrong (DIRS 101583-1968), Fleck (DIRS 150625-1970), CRWMS M&O (DIRS 100127-1998), and Dunne (DIRS 102861-1986).

24. DOE has updated the subject reference.

25. DOE has clarified this paragraph in Section 3.1.3.2 of the EIS, as suggested by the comment.

26. The comment is correct; text in Section 3.1.3.2 has been revised for clarity. The Solitario Canyon fault is not the only block-bounding fault identified.

27. DOE has reorganized the paragraph in question to discuss the Ghost Dance fault, which occurs in the middle of the repository block, before discussing the northwest-trending faults.

28. The description of faults in Figure 3-9 of the Final EIS has been clarified.

29. DOE has changed the legend on the mapped faults figure in Section 3.1.3.2 to label the arrows in the figure as strike-slip faults.

30. DOE believes that it has made the table in Section 3.1.3.2 of the EIS more accurate by removing the word "late" from the column heading related to Quaternary displacement.

31. During EIS preparation, DOE decided to omit a seismicity map in favor of a simpler presentation. The Department made this decision with the understanding that more detailed seismic information is available in the *Yucca Mountain Site Description* (DIRS 151945-CRWMS M&O 2000). With regard to showing faults on a seismic map, seismic events do not correlate with mapped surface traces or Quaternary faults, as indicated in Section 3.1.3.3 of the EIS.

32. DOE believes the paragraph is correct as written. The main point of this paragraph is that the strain rate is significantly less than the rate reported by Wernicke et al. (DIRS 103485-1998), which did not account for the coseismic and postseismic effects of the 1992 Little Skull Mountain earthquake.

33. The EIS presents the results of various investigations on mineral and energy resources. DOE considers the likelihood of finding oil or gas to be low in the vicinity of the proposed repository. Drilling of numerous boreholes to depths beyond 1829 meters (6,000 feet) in the area found no indications or shows of oil of gas. Therefore, DOE decided not to include a detailed discussion of mineral and energy resource potential in the EIS, but rather to refer the reader to the numerous references that discuss these issues. This approach is consistent with the regulations of the Council on Environmental Quality [40 CFR Part 1501.7(a)(3)] that direct agencies to identify and eliminate from detailed study those issues which are not significant.

34. DOE, in cooperation with Nye County, has initiated a program (called the Early Warning Drilling Program) to characterize further the saturated zone along possible groundwater pathways from Yucca Mountain, as well as the relationships among the volcanic, alluvial, and carbonate aquifers. Information from the ongoing site characterization program and from the performance confirmation program (if Yucca Mountain is approved for a repository), would be used in conjunction with that of the Early Warning Drilling Program to refine the Department's understanding of the flow and transport mechanics of the saturated alluvium and valley-fill material south of the proposed repository site, and to update conceptual and numerical models used to estimate waste isolation performance of the repository. When DOE published the Draft EIS, only limited information from the Early Warning Drilling Program was available. Since then, however, this program has gathered additional information (see Section 3.1.4.2.1 of the Final EIS).

35. The EIS describes why the quantity of water moving through the proposed repository would be small compared to other sources of recharge in the region and to the amount of groundwater moving through the area. DOE believes that presenting ranges of infiltration rates in this case would add unnecessary complexity. More information, including temporal and spatial ranges of net infiltration, is in the Water Source and Movement discussion in Section 3.1.4.2.2 of the EIS.

    DOE disagrees that description of an average net infiltration over the area of the repository is misleading. (It should be noted that the EIS now presents a different infiltration estimate due to the results of an updated infiltration study.) The EIS also considers smaller areas of higher and lower infiltration. Section 3.1.4.2.2 identifies infiltration rates over an order of magnitude higher in areas where thin alluvium overlies highly permeable rock. It would be misleading to imply that these higher infiltration rates occur over large areas.

DOE agrees that it is difficult to predict which fractures or faults would act as highly transmissive zones. However, much has been learned from studies, particularly chlorine-36 studies, that have suggested a correlation between subsurface locations where there is evidence of "fast pathways" (less than 50 years) and physical conditions in the mountain and on the surface. The Water Source and Movement discussion in Section 3.1.4.2.2 describes these correlations.

36. Thank you for your comment.

37. DOE acknowledges and appreciates the offer of technical support from the U.S. Department of the Interior and its individual bureaus on the Yucca Mountain Project monitoring programs. Such cooperation will inevitably increase the knowledge base on the local environment and help ensure minimal impacts of the Proposed Action on regional wildlife and other natural resources.